

MITCHELL CREEK
HYDROLOGIC INVESTIGATION

**Incorporating both water quantity and quality
considerations in urbanizing watersheds.**

by

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EXECUTIVE SUMMARY

Hydrologic modeling is useful for local communities to evaluate the effects of planned zoning on streamflow within a watershed. Urbanization, if left unchecked, can cause detrimental impacts to a watercourse. These impacts include increased peak flows, reduced baseflow, channel erosion, elimination of pools and riffles, less diverse fish and aquatic communities, increased water temperatures, increased soil erosion and increased pollutant loads to the watercourse. Some of these impacts are due to the increased volume of runoff which results from urbanization and its associated paving and land use changes. Other impacts are due to the increased pollutants and sediments which wash off impervious areas and construction sites.

A hydrologic model was developed which divided the Mitchell Creek Watershed into 29 subwatersheds. Based on land use and soil information from each subwatershed, the model develops flows from each area. These flows can be combined at various locations to represent a composite runoff hydrograph. With this model, the land use for a subwatershed can be changed and the potential impact on downstream flows can be evaluated. The model can also be used to evaluate regional retention sites.

The model was used to evaluate what affect potential urbanization would have on peak streamflows in Mitchell Creek. Three scenarios were evaluated:

- 1) Existing land use conditions using 1978 land use information;
- 2) Future land use assuming $\frac{1}{4}$ acre residential development throughout the watershed;
- 3) Future land use based on Township Zoning Plans.

The scenarios were modeled assuming no retention/detention requirements. The 2-year, 25-year and 100-year 24 hour rainfall events were used with the model. Model results down to Four Mile Creek (da = 12.1 square miles) are summarized below:

	1978 Conditions		$\frac{1}{4}$ Acre Development		Zoned Development	
	2-yr.	100-yr.	2-yr.	100-yr.	2-yr.	100-yr.
Mitchell Creek d/s of Four Mile Creek, DA = 12.1 mi ²	90 cfs	820	210	1340	420	1780

If no retention/detention requirements were imposed with the zoned conditions, the above comparison indicates that there would be a two-fold increase in peak flows produced by the 100-year rainfall and a four-fold increase in flows produced by the 2-year rainfall. This increase in flow would cause additional flooding and channel scouring which would affect the quality of the creek. The amount of flow increase for some of the individual subwatersheds was even more dramatic, especially those which are currently meadow and are zoned to be commercial. For these subbasins, the 2-year peak flows increased by as much as a factor of 10. The reason for this is that with sandy soils in a meadow condition most of the 2-year rainfall infiltrates into the soil. The majority of the soils in the Mitchell Creek watershed are sandy or sandy loams which means that adding impervious surface will cause a much higher percentage of runoff.

Several road crossings which had small culverts with a high road fill were evaluated for their ability to attenuate (lower) peak flows. The model results indicate that many of those roads are effective in reducing peak flows and in that respect are acting like detention ponds. Any future road project which enlarges an existing small culvert that has more than 4 feet of road fill should be evaluated for downstream impacts. A larger bridge or culvert will allow a higher flood peak to pass, thereby increasing flows and potential flooding. Another consideration is increased development will increase the frequency and duration of flooding upstream of the crossing.

Some states and communities across the country have retention/detention requirements to meet both water quantity and quality concerns. Many Michigan communities have regulations dealing with increased water quantity caused by urbanization, but very few have addressed retention/detention requirements to deal with water quality issues. In order to address both concerns, a comprehensive approach is needed. Water quantity concerns are usually dealt with by requiring that retention/detention be used to limit peak runoff rates after urbanization to what they were before development or less. This requirement is usually applied to the entire community even though detention at the downstream end of the watershed could actually increase flows due to delaying of the peak (Figures 7a, b, c). Modeling can be used to address this potential problem, at least on a regional scale.

In order to address water quality concerns, several things can be done which are often called Best Management Practices (BMP's). Some of these are listed below.

- 1) Provide a buffer or greenbelt along all streams, drains, wetlands and lakes. Requirements for buffer widths vary from 25 to 200 feet (on small streams water temperatures may increase 1.5° F per 100 feet when flowing through unshaded reaches).

- 2) Maintain as much vegetation and green area as possible.
- 3) Use grassed swales instead of curb and gutter.
- 4) Disconnect downspouts from sewers.
- 5) Use sediment sumps in storm sewers.
- 6) Provide shade for retention/detention ponds and their inlets and outlets.
- 7) Restrict development in environmentally sensitive areas.
- 8) Possible use of cluster development which minimizes the disturbed area.
- 9) Use strict soil erosion controls at construction sites.
- 10) Avoid clear cutting a development site all at once. Do the construction in a staged manner, stabilize one area before moving on.
- 11) Use a sediment basin at construction sites. A recent Maryland study suggested that a basin volume sized at 3600 ft³/acre be used.
- 12) Provide retention/detention for small rainfall events up to the 2-year storm.

Item number 12 deals with retention/detention requirements to address water quality concerns. Small runoff events pick up and deliver the majority of the pollutants to a watercourse. Nationally, the amount of runoff to be treated varies from .5 inches per impervious acre up to the amount of runoff provided by a 2-year 24 hour storm. The runoff volume can be treated in two ways:

- 1) The runoff is directed to an infiltration basin or trench with no outlet. The water infiltrates into the ground within 72 hours. In order for this method to be used, the infiltration rate of the underlying soils should be .52 inches/hour. Most of the soils in the Mitchell Creek Basin are sands and loamy sands which should meet this requirement. The bottom of the basins should be 4 feet above the seasonally high ground water table. Infiltration provides for the highest removal of pollutants in the runoff and causes the least impact on increasing stream temperatures.

- 2) The runoff is directed to an extended detention or wet retention pond. The volume of runoff should be filtered out over a 24-48 hour period to allow for settling of some of the pollutants.

Typical dry detention basins with an open pipe at the bottom which allows everything to flow out does very little for water quality. Infiltration basins and retention/detention ponds can be designed to handle both water quality and water quantity concerns.

The local governmental agencies in the Mitchell Creek watershed have a draft ordinance which states the following: "... as a minimum any retention, detention or infiltration basin shall have the storage capacity to hold the increase in runoff caused by a proposed project based on the 25-year 24 hour storm. The volume is to be released over a 24 hour period at a peak release rate of .2 cfs/acre or the 2-year 24 hour peak based on grassed conditions, whichever is less." It further calls for storing back to back 100-year storms when downstream flooding or water quality concerns are critical. If this ordinance is adopted, it should address many of the water quantity or quality concerns which are identified in this paper.